DOCUMENT RESUME

ED 398 897 IR 018 078

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TITLE Introducing Interactive Multimedia to Young Children: A Case Study of How Two-Year-Olds Interact with the Technology.
PUB DATE [Mar 96]
NOTE 42p.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Ability; *Age; *Appropriate Technology; *Case Studies; Child Development; Computers; Computer Software; Interaction; *Multimedia Materials; Prior Learning; Relevance (Education); *Toddlers
IDENTIFIERS *Age Appropriateness; *Interactive Systems; Meaningful Learning; Role of Technology

ABSTRACT

Interactive multimedia programs have found their way into the hands of young children. This case study attempts to determine how two year old children interact with interactive multimedia technology, and addresses the following questions: is it appropriate to include the interactive multimedia technology in the same context as other objects like sand, books, water, toys, and television for children as young as two years old?; can two year old children use interactive multimedia programs?; and, how young is too young for children to be introduced to the technology? An interactive multimedia program was developed for this purpose and used with children two years of age. The results showed that children two to three years of age can engage in computer interactions. It appears, however, that purposeful and meaningful interactions may not begin until the child is approximately two and a half years old. Prior knowledge has a strong role in a very young child's computer experience. Human interaction is shown to be vital to help these young children understand the computer environment. The keyboard seems to be the most appropriate input device for two to three year old children. (Contains 32 references.) (Author/SWC)

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ED 398 897

# Introducing Interactive Multimedia to Young Children: A Case Study of How Two-Year-Olds Interact with the Technology

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RUNNING HEAD: Interactive Multimedia for Young Children

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IR018078

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**Abstract**
(187 words)

Interactive multimedia programs have found their ways into the hands of young children. Is it appropriate to include the interactive multimedia technology in the same context as other objects like sand, books, water, toys, and television for children as young as two years old? Can the two-year olds use interactive multimedia programs? How young is too young for children to be introduced to the technology? This case study attempted to understand how two-year-olds interact with the interactive multimedia technology. An interactive multimedia program was developed for this purpose and used with children two years of age. The results showed that children 2 to 3 years old can engage in computer interactions. It appears, however, from this research that purposeful and meaningful interactions may not begin until the child is about two-and-a-half-years-old. It is also apparent that prior knowledge has a strong role in a very young child's computer experience. Human interaction is shown to be vital to help these young children understand the computer environment. The keyboard seems to be the most appropriate input device for 2- to 3-year-olds.

According to the National Association for the Education of Young Children (NAEYC), "[h]ow young children learn should determine how teachers of young children teach." "For children to understand fully and remember what they have learned . . the information must be meaningful to the child in context of the child's experience and development" (Maxim, 1989, p. 438). Blocks, puppets, tapes, sand, water, toys, play houses, and other equipment have traditionally been essential for young children's learning (Swick, 1989). Computers, as another form of enrichment, are becoming increasingly popular. The pervasive use of computers in every aspect of our lives challenges educators to examine the potential and the role that computers should have in young children's education (Calvert, 1994; Haugland & Shade, 1988; Riding & Powell, 1986; Wright & Shade, 1994).

While there are numerous studies on how elementary school students or even kindergarten children use computers, little is known for the very young age group such as two- and three-year-olds (Brinkley & Watson, 1988; Piel & Baller, 1986; Riding & Hardaker, 1986; Shade & Watson, 1987; Swigger & Swigger, 1984; Wright & Shade, 1994). Very young children investigate the world by experiencing and interacting with it, and computers are a part of that world. Is it appropriate to include the computer in the same context as other objects like sand, books, water, toys, and television? Two- and three-year-olds can operate electronic equipment such as holding a telephone and pushing buttons on a television or VCR. Can they use interactive multimedia programs?

Due to recent technological advances, computer software not only becomes easier to use, but also is more accessible to schools and homes. Interactive multimedia programs, in particular, have found their ways into the hands of young children. How young is too young for children to be introduced to the technology?

## Purpose of the Study

The purpose of this study was to understand how interactive multimedia technology can be used for very young children. The research question that guided this study was "How do two-year-olds interact with multimedia programs?" This research question was examined from

three aspects: (1) How long can a multimedia program engage the young children? (2) How do young children play with a multimedia program? and (3) How do young children react to a multimedia program.

Interactive multimedia technology, with its use of text, graphics, audio, video and animation, can provide a more realistic learning context and is particularly appropriate for young children. To explore this research question, an interactive multimedia program was designed and developed for the purpose of research. We will describe this program briefly and report on use of the program by children two years of age.

## Research Framework

Effective learning environments for young children can provide opportunities for interaction and socialization through hands-on experiences, play, discovery, and creativity (Ward, 1990). Activities found as part of these environments include the use of manipulatives like blocks; use of art materials like crayons, paint, and clay; experiences with sand and water, and picture books and music. Increasingly, a growing body of early childhood educators is interested in the potential computers would have in adding another dimension to a young child's early learning experiences. Literature indicates that computers can be effective resources when used in age-appropriate ways (Alloway, 1994; Shade, Nida, Lipinski, & Watson, 1986; Wright, Shade, Thouvenelle, & Davision, 1989).

### Attention, Age, and Young Children

Most children, even very young children, seem to have longer attention spans when watching television or videotape (Morgan & Greene, 1994). Young children pay attention to content that fits into their prior knowledge. Animation, adult female voices, and familiar sound effects often attract a young child's attention (Clements & Nastasi, 1993). These techniques are a trigger to the child that the content is going to be understandable and interesting. King and Alloway (1992) report research suggesting increased concentration spans in children both in their interactions with each other and with the technology. While Morgan & Greene (1994) report that preschool children become quickly bored with the materials used in traditional

sorting tasks, the young children's length of attention increased significantly and it was easier for the experimenters to keep the children on task when the children were shown videotape presentations. Television and videotape have inherent characteristics that can have powerful effects on young children's attention, but communication is one way. Computers, on the other hand, not only incorporate the attractive aspects of television and videotape, but also allow interaction by children. In a study by Shade et al. (1986), it was found that preschoolers' attention was drawn to the monitor -- knocking on an animated door, touching objects that danced across the screen, and even kissing the character on the screen. Some of these children watched the keyboard and only attended to the screen when given auditory cues, while others watched the screen when manipulating the keys and appeared to draw connections between certain keys and screen content. The children in this latter group stayed at the computer longer than the children in the first group who had not made that connection.

While some concerns have been expressed about computers being too hard to use by very young children (Simon, 1985), research has indicated that computers can be operated and managed successfully by children as young as three and four years old (Brinkley & Watson, 1988; Liu, 1996; Shade et al., 1986). In a study by Liu (1996), it is reported that young children between three and five years of age are capable of using the mouse to control an interactive multimedia program after being exposed to the technology briefly. The technology with its video, audio, and graphics engaged children for a longer period of time. The children demonstrated great interest and had little difficulty in adjusting to the new learning environment. In balance with other activities such as adult-child conversations, peer interactions, block construction, creative art, experimentation with sand, water, dirt, and clay, a microworld through computers may provide an interesting, stimulating, and enjoyable environment as an adjunct to their other experiences. Appropriate computer uses can contribute to early childhood education, especially since girls and boys do not differ in their use of the computer when very young (Clements & Nastasi, 1993).

**Play, Learning, and the Computer**

While it is no secret that young children love to play, it is through play that most of their learning takes place (Fiddy & Yam, 1984). Even by the time a child reaches 18 months, the child has acquired skills needed to engage in cooperative games, often without any structuring by the adult (Hughes, Elicker, & Veen, 1995). While very young children do not necessarily need to know how to read, Fred M. Rogers, creator and host of Mister Rogers' Neighborhood, said, "they do need to know how to play" (Rogers, 1989). Play is the preeminent educational activity of early childhood (Berk, 1994). One theory of play proposes that play progresses through three phases: exploration, manipulation which includes experimentation, and mastery which includes meaningful play (Escobedo, 1992). In other words, meaningful play is a learned activity, and it is this activity, often referred to as "child's work," that very young children appear to know how to do the best. Escobedo (1992) equates the three phases in the development of meaningful play to the sequence of events that occur in the development of computer capabilities -- exploration of the computer, manipulation of the computer environment, and mastery which includes meaningful usage. According to Escobedo, when young children learn to use computers, they depend on play and its components (exploration, manipulation and experimentation, and mastery) just as they do when they learn about other play activities (1992).

When young children play with the computer, their manipulation of the keyboard not only gives them practice in fine motor skills development, but their progression through the software program helps them master the pattern or mode of the concept presented. This in turn allows them to acquire some perspective on cause-effect relationships and helps them gain confidence in their use of the technology (Haugland & Shade, 1988; Swick, 1989). Play on computers can involve young children in explorations that foster emerging literacy (Irwin, 1987). Computer activities can provide a valuable experience to children if the programs allow the opportunity to increase skills systematically (such as doing something faster each time) or if task complexity or difficulty is increased (Swigger & Campbell, 1981).

Important thinking skills identified by Anselmo and Zinck (1987) that have the potential for enhancement in the computer environment include comprehension, memory, evaluation, and creativity. According to them, creativity may just be the thinking skill that the computer is most effective in strengthening. While computers cannot substitute for experiences in which young children can discover with all five of their senses (Anselmo & Zinck, 1987; Ward, 1990), computers can enrich learning environments (Shade, Nida et al., 1986; Wright & Shade, 1994), and can add a play experience utilizing the young child's seeing, listening, and touching abilities.

The literature has indicated that computers can be a valuable tool for learning if used in developmentally appropriate ways. While there were numerous studies supporting computer usage by children four years of age and older, there seems to be little data on the subject specifically related to two- and three-year-olds. It is generally agreed that very young children know more than they can verbalize (Shade et al., 1986). More research is needed in attending to the learning needs of this age group.

## The Design and Development of A Multimedia Program for Two-Year-Olds: The First Stone

### A Description of the Program

In an attempt to understand how two-year-olds use the interactive multimedia technology, a multimedia program was designed and developed. This program was designed with the intention to provide 2-year-old children an additional venue to explore, discover, and learn. It introduces simple "cause and effect" experiences to children by helping children understand the connection between their keyboard strokes and what happens on the screen. The introduction of the concepts such as color and classification are embedded in those experiences. The program was developed using Macromedia's *Authorware* authoring tool and consists of (1) an opening activity, (2) three color activities, and (3) three classification activities. The Opening Activity acquaints the child with the computer. Color activities guide the child towards gradual independent interaction with the computer through the use of the

basic colors red, green, blue, and yellow. Classification activities use children's favorite cartoon characters to introduce such concepts as big and little, food and toys.

The multimedia program uses audio, animation and color graphics. In most cases, a key press by a child will initiate action of some kind. In the following, the opening activity, two color activities and two classification activities are explained. In addition, some screens are included.

**Opening Activity.** The opening activity introduces the computer screen and keyboard to the young child and requires assistance from a *helper* who can be a parent, adult, or older child. Red, green, blue, or yellow 3/8-inch Dymo plastic coding tape squares cover some of the keyboard buttons, and Eeyore's picture covers the *Return* button (see Figure 1). The keyboard buttons that are not covered with one of these special markers are disabled. The initial screen shows Winnie-the-Pooh, Eeyore, and Tigger in the Hundred Acre Wood. The computer begins, "Hi! This is a computer." The helper points out the computer to the child. The computer says, "This is the screen." The helper points out the screen. The computer says, "This is the keyboard." The helper points out the keyboard. The computer says, "The keyboard has buttons on it. Sometimes things happen here, on the screen, when you push one of these buttons." The helper points out the buttons and then the screen as the computer speaks. The computer says, "This is Eeyore, right here." The helper points out Eeyore on the screen. The computer says, "This is Eeyore's button." The helper points out Eeyore's button. The computer says, "See what happens when you push Eeyore's button." When the child pushes Eeyore's button, Eeyore says, "Hello," and the screen fades to black.

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Insert Figure 1 Here

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**Color Activity 1: Instruction.** The color activities use the four basic colors that most 2- to 3- year old children are familiar with or developing a familiarity with to help children make connections between their use of the keyboard to actions on the screen. Color Activity 1

provides the instruction. Color Activities 2 and 3 provide practice. When the child proceeds from the opening activity to Color Activity 1, the computer says, "There are different colors on the keyboard." The helper points out the colors. The computer asks, "Where are the red buttons on the keyboard?" Pause. "If you push one of these red buttons on the keyboard, you can make something happen up here on the screen. Try it."

When a red button is pressed, the color red fills the screen and Eeyore says, "Red." The computer then asks, "Where are the green buttons on the keyboard?" Pause. "If you push one of these green buttons on the keyboard, you can make something happen up here on the screen. Try it." Whatever color button is pushed, that color fills the screen and Eeyore says that color's name. The computer does not ask the child to push a new color button until after the requested button has been pushed. The third and fourth colors requested are blue and yellow respectively. After the yellow button has been requested and pushed, the screen fades to black surrounding Eeyore in the center. Eeyore says, "Hello."

**Color Activity 3: Guided Practice.** The computer screen is filled with four colors: red fills the upper left quarter; green fills the upper right quarter; blue fills the lower left quarter; and yellow fills the lower right quarter. The computer says, "Push a red button."

When a red button is pushed, a funny smile face appears in the red quadrant and Eeyore says, "Red" (see Figure 2). The computer says, "Push a green button." When a green button is pushed, a different funny smile face appears in the green quadrant and Eeyore says, "Green." The computer gives instruction to push other two buttons. When they are pressed, a funny smile with the corresponding color appears on the screen. This sequence can be repeated as many times as the child desires.

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Insert Figure 2 Here

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The classification activities introduce the concept of classification to young children in three different concrete examples. In the first activity, children learn to classify big things from

little things. In the second activity, children learn to differentiate things they can eat as food from things that they cannot eat. In activity three, children learn to differentiate things that they can play with as toys from those they cannot play with as toys. Each activity follows a similar structure: using graphics, animation, voice and music for presenting information, and asking children to respond using colored keys on the keyboard. Feedback is provided to each response whether it is correct or incorrect. Classification Activity 2 is equivalent in complexity to Classification Activity 3. Both of them are more complicated than Activity 1.

**Classification Activity 1: Big/Little**. A rocky woodland scene with the familiar Simba, Nala, and Zazu characters from the movie The Lion King appears on the screen. On the ground between Simba and the rocks sit a little drum, a big drum, a little ball, and a big ball. The computer says, "Simba, Nala, and Zazu see some toys. Some of them are big and some of them are little. Can you help them put the big ball by Simba and the little ball by Nala?" Pause. Zazu flies from the ledge to sit on top of the big ball (see Figure 2). The computer says, "Is Zazu on top of a big ball? Push a red button for yes, push a yellow button for no. Push red for yes, push yellow for no." When the child pushes the red button, which is a correct response, an animation occurs to reinforce the concept of big and little and the computer says, "Zazu loves big balls." If the child pushes a yellow button, an incorrect response, the computer says, "Zazu loves to sit on big balls." Pause -- and the question is posed to the child again. After three incorrect responses, the correct response animation and sound are played and the activity advances to the next interaction. Following the same structure, another example is given where a child is asked to differentiate the big and little drums.

**Classification Activity 2: Food.** The interior of Winnie-the-Pooh's house is presented on the screen. Pooh, Piglet, and a red wagon stand in the foreground. Various items sit on shelves and on the floor. These include an apple, a jar of honey, a pie, a bottle of lemonade, a ball, some balloons, and a drum. The computer says, "Pooh and his friends want to go on a picnic. They want to take some food and toys with them. They want to put into the wagon things they can eat. Let's help them." Pause. "Can they eat an apple? Push a red

button for yes or a yellow button for no. Push red for yes -- push yellow for no." When the child pushes a red button, which is a correct response, the apple floats into the wagon, a sound effect dings, and the computer says, "Yummmm. Eeyore loves apples" (see Figure 2). If the child pushes a yellow button, an incorrect response, the computer says, "I think someone likes to eat apples. Maybe it's Eeyore," and the question is posed again for the child. After three incorrect responses, the correct response animation and sound are played, and the activity advances to the next interaction.

The computer says, "Can they eat a ball? Push a red button for yes or a yellow button for no. Push red for yes -- push yellow for no." When the child pushes a yellow button, a correct response animation plays, and the computer says, "Balls are fun to play with, aren't they?" If the child pushes a red button, an incorrect response, the computer says, "A ball is a toy. You can play with it," and the question is posed again for the child. After three incorrect responses, the correct response animation and sound are played, and the activity advances to the next interaction. Following the same structure, pie and honey were used as more examples in this classification activity. Appropriate questions and animation were used.

**Multimedia Design Considerations**

In designing this multimedia program for children two years of age, several factors that should be present for good computer environments for young children are taken into consideration (Haugland & Shade, 1988; Ward, 1990; Wells & Burts, 1990; Wright & Shade, 1994). These factors are age appropriateness, learner control, feedback, real-world representation, and expanding complexity.

The concepts introduced and the objects used in this program are built upon those aspects of learning that are already familiar to very young children. Many two-year-olds are already aware of the four basic colors. Many know what an apple, a wagon, a ball, a drum, or a balloon are, examples used in this program. The presentation of the color and classification concepts is embedded in scenes of children's favorite stories: Walt Disney's *Winnie-the-Pooh* and *Lion King*, something children can easily relate to. The activities used model a small aspect

of real life: A child is asked to help Pooh and Piglet put food into a wagon for a picnic. The food items to select are common picnic food choices such as an apple and a pie.

Taking advantage of interactive multimedia, the program makes use of audio, graphics and animation, when appropriate. A female, mother-like voice is used and activated with or without a keypress from a child to provide the instruction as well as the feedback. She guides the child during his or her use of the program. As most two-year-olds cannot read yet, no text is used except for the quit button on the first screen and the words "the end" on the last screen for the helper. To make the experience more interesting and fun, animation is used whenever possible. For example, animation is used when each color is introduced in the color activities, and when the child is introduced to the concepts of big/little and food/toys in the classification activities. Instruction and meaningful feedback are provided using audio and in many cases accompanied by animation. For example, after a child chooses an incorrect response when asked if Zazu is on top of a big ball, an animation sequence will play to indicate that Zazu is on a big ball, not a little ball, and a female voice will say, "Zazu loves to sit on big balls." Efforts are made to ensure the screens are uncluttered and simple for the young children. The faces displayed in Color Activity 3 show bold eyes, noses, and mouths and no other detail (see Figure 2). The graphics in the three classification activities display brilliant colors. The lush, green grassland background contrasts vividly with the yellow colors of Simba and Nala and the bright orange beak of Zazu in Classification Activity 1. The frosty pastels of Pooh's kitchen in Classification Activities 2 and 3 enhance the red wagon, red and blue ball, and other objects used in the activity, and the only objects that are visible are the ones essential to the activity. In addition, only music with a seven-note range is used.

The activities of the program progress from simple to more complicated as the child proceeds. The Opening Activity and Color Activity 1 guide the child in using the program with the assistance from the helper. Gradually the helper withdraws in Color Activities 2 and 3 and the child directs the computer actions alone. Classification Activity 1: Big/Little is on a little

more difficult level than the preceding color activities. The last two activities, Classification Activity 2: Food and Classification Activity 3: Toys are the most difficult.

At the age of two, most children's fine motor skills have not been fully developed. Their hand-eye coordination is not expected to be at the level required for effective operation of the mouse. Therefore, for this study, the input device chosen is the keyboard, and the input method is by single-keystroke operation. For many young children who have the experience of pushing telephone and remote control buttons, pressing single-keys on a keyboard should resemble to some extent what they have already known. From the beginning, the program gives the child control of the program, while at the same time providing an opportunity for assistance from a helper. The child can progress through the program at his or her own pace by means of his/her keyboard actions .

The main techniques used in this multimedia program in relation to various design considerations are summarized in table 1.

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Insert Table 1 here

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**Method of Evaluation**

To answer the research question, "How do two-year-olds interact with the interactive multimedia program?" children of two years old were asked to participate in the study. This study was exploratory in nature and consisted of two phases. In the first phase, the children were introduced to the multimedia program described above. They were asked to play with it at their own pace. Based upon the result of Phase I, modifications were made to the program and the program was used again in the second phase of the study. The same children participating in Phase I were asked to participate in Phase II of the study. The purpose of using this trial and refinement evaluation model (Hsi & Agogino, 1994) was to gain a better understanding of how young children can use the interactive multimedia program.

## Phase I of the Study

### Participants

This study took place in a mid-size Southwestern city. A number of children at the age of two that the authors knew directly and indirectly were solicited to participate in the study. The mothers of four children volunteered. The average age of the four children was 2 years and 2 months (2:2, see Table 2). The older girl attended a mother's-day-out program two mornings a week during the previous school year, while the younger girl had had no organized play experience. Both boys attended a nursery school program two mornings a week during the previous school year.

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Insert Table 2 Here

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The exposure to computers among these children was varied. Child 1 had a computer at home. She had observed her parents operating it, and had used a keyboard, but not a mouse before. There was also a computer in Child 2's home, and this child had observed his parents using it. He had also operated a keyboard before. He had used a mouse before but without success. Child 3 had had no exposure to a computer. There was no computer in his home, he had not observed anyone in his family operating a computer, and had never used a keyboard or a mouse. There was no computer in Child 4's home, although she had observed her parents operating a computer and had used a keyboard before, but not a mouse (see Table 2).

### Data Sources

There are three data sources for this study: (1) observational data; (2) videotaping transcripts; and (3) interviews with the mothers. Observations were made during the children's use of the program. The sessions during which the children used the program were videotaped. Data from observations and videotaping were analyzed according to the following categories: (1) length of the time the children were engaged in using the program; (2) children's reaction to the program -- physical, facial and verbal expressions; (3) their "play" with the program -- the

completion of each activity, the number of activities completed, attention to keyboard, and screen, and the number of correct responses. The mothers of the four children were interviewed. The interview questions included (1) whether there was a computer at home; (2) whether the child had observed computer use before; (3) whether the child had used the computer before; (4) whether the child had used a keyboard before; (5) whether the child had used a mouse before; (6) whether the time spent using this multimedia program is more/same/less than the time the child usually spent at other non-computer activities.

**Procedure**

The study was carried out during the times that were convenient to the schedules of the children and their mothers. Each child was scheduled to one 30-minute individual session for using the multimedia program. Each child was brought to the testing site by the child's mother. A Macintosh computer and 13-inch color monitor were set up in a room. They were positioned on a child's table, and a child's chair was placed at the table. Dymo 3/8-inch plastic color coding tape was cut into squares and placed over some of the keys on the keyboard. The keys not covered were disabled. As shown in Figure 1, red covered the *q,w,a,s,z,* and *x* keys. Green covered the *r, t, f, g, v,* and *b* keys. Blue covered the *u, i, j, k, m,* and < keys. Yellow covered the *p* and *[* and *]* and *;* and ' and / keys. Velcro was used to attach a picture of Eeyore over the *Return* key. The keys were referred to as buttons in the program.

Toys were situated near the computer. All the children were told they could play with the computer for as long as they wanted, and that they could walk away from the computer and play with the toys at any time. The helper (one of the researchers) sat in a child's chair to the child's right, and the child's mother sat on the floor to the child's left. The helper guided the child during the Opening Activity and Color Activity 1 of the program, and provided assistance for other activities when needed. Each session was observed and videotaped. After the child used the program, the mother was interviewed using the questions mentioned above.

**Results from Phase I**

**Time Spent.** Child 1 spent 11 minutes at the computer and completed all but Classification Activity 3: Toys. Child 2 spent 14 minutes with the computer and completed all the activities. Child 3 spent less than 1 minute at the computer and did not complete any of the activities. Although Child 4 spent 8 minutes at the computer, she did not complete any of the activities (see Table 3). According to the observations by the mothers, two of the children (Child 2 and Child 4) spent about the same amount of the time doing this computer activity as the other non-computer activities. Child 1 spent more time playing with this computer program than other non-computer activities. Child 3 spent less time in using this computer program.

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Insert Table 3 Here

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**Children's Play With the Multimedia Program.** When the children approached the computer, all of them immediately started pushing buttons at random on the keyboard. All four children completed the opening activity with guidance from the helper, during which they all looked up at the screen and back down to the keyboard as directed by the computer instruction. Of the four children, Child 1 and Child 2 completed Color Activity 1, although they needed help to get started and encouragement to continue. They needed assistance to push the red, green and Eeyore buttons, but they were able to push the blue and yellow buttons on their own as the activity continued (see Table 4). Although Child 3 and Child 4 could direct their attention to the screen, keyboard and the cartoon character Eeyore at the computer instruction, they did not complete Color Activity 1, nor any other activities thereafter.

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Insert Table 4 Here

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Color Activity 2 was a free-play activity. The children were given the opportunity to push any of the buttons they wanted to push. Child 1 pushed 12 keyboard buttons, and Child

2 pushed 13 keyboard buttons. Often they pushed the same button more than one time. Both children required encouragement to push the buttons they wanted and to look at what happened on the screen when they pushed the buttons. Child 3 and Child 4 did not participate in this activity or any of the remaining activities.

For Color Activity 3, Child 1 pushed each button after being requested to do so by the computer. She did not need any help from the helper. Child 2 still needed some guidance from the helper during the entire activity, but successfully pushed Eeyore's button without help at the activity's conclusion (see Table 5).

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Insert Table 5 Here

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After the three color activities, the children proceeded to the three classification activities. Classification Activity 1 deals with the concept big and little. Child 1 looked at the screen while pushing the correct button for the big ball, but then looked around at the other toys in the room. When the computer asked, "Is Simba on top of a little drum? Push a red button for yes, push a yellow button for no," she appeared to be confused by the question even when it was repeated. So she proceeded to push each color button one time as if to be sure she had all bases covered (see Table 6). Child 2 was very quiet and focused his attention on the screen and the keyboard. Although he needed help with the big ball, he completed the little drum portion without any assistance (see Table 6).

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Insert Table 6 Here

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When the children proceeded to Classification Activity 2, Child 1 began to lose interest. She turned away from the screen and looked around behind herself. She looked at the screen and keyboard and then looked up and around the room. Child 2 was still very quiet, but was intent on the screen and keyboard. Both of them, however, were able to complete the activity

without any help. Except for the last question in this activity, Child 2 pushed the correct buttons to the questions on the first trial (see Table 6). Child 1 also gave correct responses to the questions (see Table 6).

Child 1 lost interest completely during the last classification activity. She stopped in the middle of it and pushed Eeyore's button. When asked if she wanted someone else to have a turn, she said, "Yes." Child 2 barely finished this last activity of the program. His mother, helped to repeat the first question to him, and the child answered her, instead of the computer, correctly. His answer to the third question was made to his mother. During the fourth question, he began pushing random keys (see Table 6).

**Children's Reaction to the Multimedia Program.** All the children responded quickly to the keyboard as soon as they were placed in front of the computer. They started to push the keys and seemed to like pushing them. The children's response to the program was varied. Although Child 4 did pay attention to the big ball question in Classification Activity 1, her interaction with the program was mainly through her mother. Child 3 took Eeyore's picture off the button and pushed keys at random. He quickly lost interest in the computer and played with other toys most of the time. Child 1 and Child 2 were more involved with the program during most of the activities. Child 1 laughed when Zazu flew on top of the big ball. Her eyes tracked the correct response to the Lion King ball animation. Child 2 kept time to the music with his leg, and responded to the cues given by the computer.

**Summary of Results in Phase I**

Two girls and two boys two years old participated in Phase I of the study. The time they spent in playing with the interactive multimedia program was about the same as they played with other non-computer toys. The two older children who had relatively more computer exposure (Child 1 and Child 2) completed most of the activities with or without assistance from an adult. The two younger children who had no computer exposure (Child 3 and Child 4) did not complete any of the activities. Child 1 and Child 2 could use the single-

stroke keys with little difficulty. Child 1 and Child 2 responded to the cues provided by the multimedia program while Child 3 and Child 4 did not.

## Phase II of the Study

### Revisions Made to the Multimedia Program

Based upon the evaluation results in Phase I, revisions were made to the interactive multimedia program, *The First Stone*. The changes reflected the following aspects: (1) simplified and more directive verbal instruction was given; (2) more time was built in to allow a child to respond; (3) in the opening activity, the relationship between the visual displays of the colors with their associated words were made more visible and clearer; (4) some oral instruction was re-recorded with slower speed and more emphasis on the key words; (5) in several activities, better indication was given to establish the relationship between what was displayed on the screen and what was spoken; and (6) brighter color plastic coding tape was used to cover the keys. For example, in Phase I there appeared to be some confusion with the wording "if you want to do something else, push Eeyore's button." A more direct approach "Do you want to play a different game? When you do, push Eeyore's button" was used (corresponding to item 1 above). In the Big/Little classification activity, when the script read "Simba, Nala, and Zazu see some toys. Some of them are big," the big ball and the big drum on the screen blinked three times. The little ball and the little drum blinked three times when the script continued as "and some of them are little" (corresponding to item 5 above).

### Participants

The same four children participating in Phase I of the study were again asked to participate in Phase II. The mothers of Child 1, 2, and 4 agreed to join. Child 3 was unavailable. Phase II took place approximately six months later. The three children were six months older than they were: Child 1 was 3:1, Child 2 was 2:10 and Child 4 was 2:1. Child 4 had minimal computer exposure since Phase I of the study while Child 1 had been exposed to computers about five times since Phase I and Child 2 had been exposed about a dozen times according to their mothers. There was no indication, however, that the children remembered

seeing the program before. The three children were asked to use the program in two consecutive sessions, sessions A and B with a week in between, to see if multiple exposures to the program would help their use of the program.

**Data Sources and Procedure**

Phase II of the study occurred in a similar setting as in Phase I. The same data sources and procedure were used. In addition, the mothers were asked if the child had observed or used computers since he or she participated in Phase I of the study.

**Results from Phase II**

**Time Spent.** According to the observations by the mothers, the children spent about the same amount of time doing this computer activity as they spent in non-computer activities with the exception of Child 2 who spent less time with the computer program than in other non-computer activities during Session B. The length of the time spent varied from a minimum of nine minutes to a maximum of thirteen minutes and five seconds (see Table 3).

**Children's Play With the Multimedia Program.** All three children completed the opening activity with some guidance from the helper (see Table 4). Child 1 and Child 2 completed Color Activity 1 independently. Child 4 needed help to push the buttons. In Session A, Child 4 also needed assistance in guiding her attention to the keyboard and screen as the computer instruction progressed. However, in Session B she directed her attention appropriately to the screen, keyboard, and the cartoon character Eeyore along with the computer instruction.

For color Activity 2, the children were given the opportunity to push any of the buttons they wanted to push. Child 1 pushed Eeyore's button without pushing any colored buttons during both Sessions A and B. Child 2 pushed 5 keyboard buttons in Session A and then Eeyore's button. In Session B he pushed 2 keyboard buttons. He then pushed Eeyore's button. Child 4 did not push any buttons during Session A. During Session B, however, Child 4 pushed 9 keyboard buttons at random after the helper suggested she push some buttons. It is

interesting to note that Child 4 only pushed the colored buttons. She then pushed Eeyore's button without any prompting.

For Color Activity 3, Child 1 and Child 2 pushed each button after being requested to do so by the computer. Neither child needed any help from the helper. Child 4 did not push any of the buttons during Session A, but with some guidance she successfully pushed each color button when requested and Eeyore's button at the activity's conclusion in Session B (see Table 5).

After the three color activities, the children proceeded to the three classification activities. Child 1 completed both sessions of Classification Activity 1 with ease. Child 2 finished the activity in Session A successfully. But during Session B, he began to pay more attention to another child, who happened to be in the room, than to the computer activity. Child 4 responded to the computer animation and repeated "Lion King" several times during Session A of Classification Activity 1. She also pushed the correct color buttons after being helped by her mom in Session B. While attempting to touch the computer screen and discovering she could not reach it, Child 4 picked up a blue 4-inch-long block, touched the screen with it, and smiled. Child 4 was able to direct her attention to the screen and keyboard, and completed the first classification activity with assistance (see Table 7).

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Insert Table 7 Here

---

The children then proceeded to Classification Activities 2 and 3. Child 1 responded to her mother rather than the computer voice during the first two interactions in Session A, but was able to interact directly with the computer during the remaining parts of the activity. She also completed Classification Activity 3 successfully. She even said that she wanted to do Lion King again. Child 2 completed Classification Activities 2 and 3 independently and without much difficulty during Session A. During Session B, however, he appeared to progressively lose interest, and kept glancing over to another child who happened to be in the room. He made

no response to the computer when it asked if you could eat an apple. The helper then asked him if he could eat an apple. He immediately said, "No. Me all finished now." He got off the chair and began playing with the other child. He did not participate in the remaining two activities during Session B. Child 4 was attentive to the screen, the computer sound effects, and her mother's and the helper's voice. During Session B, she showed some response to the computer's voice. She said "Pie" to the computer after the computer asked, "Can they eat pie?" But she did not complete the two classification activities (see Table 7).

**Children's Reaction to the Multimedia Program.** At the beginning, Child 1 appeared to be shy as she only wanted to sit on her mother's lap. This shyness gradually disappeared during Session A and was not present for Session B. All three children responded to Eeyore. They also seemed to like pushing the keyboard buttons. Child 4 was more random in pushing the buttons at the beginning of Session A, but was quite deliberate in her key pushes as the session progressed. She exhibited very little randomness in her key pushes in Session B. Child 1 and Child 2 interacted directly with the computer program without additional assistance. Child 1 gasped and said "Oh!" each time Eeyore said "Hello." When Eeyore said, "Hello," she pulled both hands together at chest, raised her shoulders, grinned and looked down. When the computer said "Hi!" at the beginning of the program, Child 2 said "Hi!" to the computer. When the computer asked if he would like to play a different game, he shouted "Yea!" He bounced up and down in time to the music at the closing scene. He sang "Bum-bum-bum-bum." After the sound of the drum in a classification activity, Child 4 said, "Drum." When the balloons moved across the screen to Piglet, she pointed to the apple and said, "Eat the apple." She moved her body up and down in time to the music during the closing song. During color activity 2, she smiled each time a smiling face appeared on the screen.

Child 4 needed more assistance in completing some of the activities. She responded more to the helper or her mother than to the computer. For example, she did not respond to the computer asking her to push a blue button, but did push a blue button in response to the helper. She had difficulty in following the three classification activities. However, she responded to

her mother when she asked the same questions. For example, when her mother asked "Is the ball little or big," she said "little" (the correct response). When her mother asked "Do you eat pie or play with it," she responded "play."

**Summary of Results in Phase II**

Three of the children who participated in Phase I joined again in Phase II of the study. Consistent to the findings in phase I, the children spent about the same amount of time in playing with the multimedia program as with other non-computer activities. Although Child 2 appeared to be distracted by the existence of another child in the room and lost interest in finishing the last two activities in Session B, Child 1 and Child 2 finished most of the activities. Unlike the finding in Phase I, Child 4 was able to finish all three color activities in Session B with some assistance. All three children were responsive to the cues in the program to some extent.

## Discussion

### How Do Two-Year-Olds Interact with the Multimedia Program

Research has shown that watching television/videotape, or doing computer activities can increase concentration spans in children of four years and older (King & Alloway, 1992; Liu, 1996; Morgan & Greene, 1994). The results of this study indicated that these two-year-old children spent about the same amount of time in using the multimedia program as in doing non-computer activities. The maximum time spent was 14 minutes while the minimum time spent was less a minute. It was noted that Child 4 increased her time spent in using the multimedia program from eight minutes in Phase I to 11.5 minutes in Session A and 13.5 minutes in Session B of Phase II. This finding suggests that computer activities can possibly increase the attention span for children four years of age or older, but not necessarily for children younger in age. As children grow older, their attention span will be longer and they can probably concentrate better in doing activities as provided by the computers.

The findings from both phases indicated that children's gender and the experience in organized play did not impact their use of computers. However, the children' age and their

prior computer knowledge did appear to have an effect both on the time spent in using the program and the number of activities completed. For Phase I of the study, two children (Child 1, a girl, and Child 2, a boy) had a computer at home. Both of them had observed their parents using the computer, and had used a computer and a keyboard somewhat prior to participating in this study. These two children spent more time in using the multimedia program than the other two children who had no prior computer knowledge (Child 3 and Child 4), and completed most of the activities without much difficulty. The result showed that the prior computer knowledge helped Child 1 and Child 2 in getting used to this new multimedia program quickly. They appeared to know what to do when placed in front of the computer and attended to the cues in the program without prompting. The other two children, on the other hand, showed little interest in this new "toy" in Phase I and did not know what to do when the program gave its instruction. The length and quality of the computer interaction appeared to parallel the depth of each child's prior computer experience. Although the two boys were only two months apart in age, child 2, who had some prior computer knowledge, was able to assimilate to a new computer environment while Child 3 was not. Furthermore, just before leaving the test area in Phase I, Child 3 walked over to the computer and picked up the mouse. He pointed the mouse at the screen as if the mouse was a television remote control. The boy's mother said her child used the remote control at home. This child appeared to be fitting the computer mouse into his existing schema for television, since he had no prior computer knowledge. This finding supports the claim that children usually fit new knowledge into their existing knowledge structures, and suggests that the more familiar the children are with the computer environment, the more comfortable they would be at the computer and the longer they would probably stay with it.

A change has been observed in Child 4's use of the program from Phase I to Phase II. In Phase I, Child 4 did not engage in any meaningful use of the multimedia program and did not complete any activities. During Phase II, however, Child 4 not only spent more time using the program but also completed some activities. With assistance from the helper or her mother,

she was able to complete the three color activities and one classification activity. In addition, her performance in Session B was better than that in Session A. She was two years and one month old when she participated in Phase II whereas she was only one year and seven months old in Phase I. When she was six months older, she was able to attend more to and understand better the computer activities. Child 1 and Child 2 who were able to complete most of the activities for both phases were also over two years. Consistent with previous research (Brinkley & Watson, 1988; Escobedo, 1992), such findings seem to indicate that though the use of interactive multimedia programs could be introduced to very young children and they could engage in exploration and manipulation activities, meaningful and purposeful play with the multimedia program did not occur until children are two and half years old. Multiple and frequent exposures to the computer environment can enhance this purposeful play.

All children were able to pay attention to the screen and the keyboard as directed by the computer instruction in the Opening Activity. Child 4, who completed no activities in Phase I, was able to complete four activities in Phase II with some assistance. Comparing the performance of Child 1 and Child 2 from Phase I to Phase II, it was found that the incidences of needing assistance were gradually reduced (see Tables 4, 5 and 6). The children became more independent in their interaction with the computer, and were able to complete most of the activities with little assistance in Phase II. It is worth pointing out that of the ten questions in the three classification activities for Phase I, Child 1 got 60% correct on the first or second trial (3 on first trial and 3 on second trial), and Child 2 got 70% correct on the first or second trial (6 on first trial and 1 on second trial). In Phase II, Child 1 got all ten questions correct (9 on first trial and 1 on second trial for session A; 4 on first trial, 5 on second trial and 1 on third trial for session B). Child 2 also got 100% correct on all ten questions for session A (5 on first trial and 5 on second trial). For session B of Phase II, Child 2 completed only one classification activity and got it right (1 correct on first trial and 1 correct on second trial), but lost interest in using the program for the next two activities. The findings indicated that Child 1 and Child 2 performed better in Phase II of the study than in Phase I.

In summary, the above results have shown that (1) children as young as two years of age can interact with the multimedia program; (2) purposeful interaction with the computers probably will not occur until children are about two and half years old; (3) as children grow older, the possibility for children to engage in meaningful play is increased; and (4) more exposure and repeated use can enhance the opportunity for children to get familiar with the computer environment and engage in meaningful interaction. These findings are in line with other research that indicates computers can add an additional dimension to enrich children's play environment and can support the cognitive development for those children who are able to use them (King & Alloway, 1992; Liu, 1996; Shade et al, 1986).

**Designing Multimedia Programs for Very Young Children**

In support of the finding that embedding new concepts in a familiar context can arouse children's interest and enhance learning (Clements & Nastasi, 1993; Liu, 1996), the children in this study were happy to see the stories they knew, Lion King and Winnie-the-Pooh. Seventy-five percent of the children took Eeyore's picture off the return key on the keyboard as soon as they noticed it, which indicated that they recognized the character. Smiles and laughs were observed and some children moved their body to the music. Animation proved to be a factor in involving very young children in computer activities. When Zazu flew on top of a big ball, one child laughed, while another stared intently at the screen. One of the children's eyes tracked the big-ball correct-response animation. She watched Zazu fly to the ledge, then watched the big ball bounce over near Simba, then the little ball bounce up and nearly hit Zazu who then flew down behind Simba. Presenting the information in an interesting and fun way, through multimedia, is important for very young children. The potential of multimedia technology, through its audio, color graphics, animation and video, can not only provide vivid real-life representations, but also allow interactivity, an aspect that TV and VCR cannot provide.

Children's response to the keyboard was immediate. Pushing the "buttons" on the keyboard was the first activity they did when placed in front of the computer. It appeared that they had little difficulty in using the single key-strokes. Not one of them attempted to use the

mouse which was by the computer (except as a remote control device as previously noted). Although research shows that the mouse is the more efficient input device for young children (Alloway, 1994), and four- and five-year olds can use the mouse well (Liu, 1996), the finding of this study suggests that using single key stroke is more appropriate for two year olds. This is because it is not only easier for two-year olds to push a button (key) physically, but also because pushing buttons is a common activity in a two-year-old world: pushing telephone buttons, pushing VCR buttons, pushing buttons on talking/music-making toys. Using a mouse, on the other hand, introduces a new type of play. As research indicates, most children prefer the use of a keyboard over the mouse when they are asked to select (Alloway, 1994).

In this study, children's desire to explore was clearly evident. For the two children who had some prior computer exposure, they demonstrated control in using single-keystroke manipulations as they journeyed through the program. For the other two child who had little or no computer exposure, their pushing keys at random also indicated their desire for exploration. Encouraging children to explore in a computer environment and allowing them to interact with the computer on their own initiative can help to develop their leadership abilities (Wright, 1994). This program builds in the human assistance at the beginning. Gradually this human assistance fades as children become more comfortable and independent with the environment. The use of this gradual fading of human assistance technique is important because, on the one hand, it provides the needed support for young children and, on the other hand, it encourages independence for the children. As the results of this study indicated, the two children who completed most of the activities, were able to transit from receiving assistance from the helper to receiving less assistance and then finally to receiving no assistance. Children's independence was encouraged by the design feature of the program. It is also important to point out that at the age of two, human interaction is of critical importance. While some children responded to the directions the computer's voice gave them, all of them were more responsive to either their mother or the helper. Research indicates that the children who gained the most from watching television or an instructional videotape tended to have mothers who watched with them and

then discussed the program with the child (Riding & Hardaker, 1986). It was the human interaction that paved the way for the children to interact independently, and therefore, gain understanding.

Feedback is very important in computer-assisted instruction. Providing prompt feedback is particularly critical to children of young age (Bowman & Beyer, 1994). Very often the multimedia aspects of a program (such as audio and animation) tend to slow down the speed of the program. As a result, a user needs to wait for the program features to come up. This study shows that when the feedback was not immediate due to the technical difficulty, the young children showed signs of losing interest and even got a little frustrated. For example, in Phase I, when Child 3 walked over to the computer, the helper encouraged the child to push Eeyore's button. The child pushed Eeyore's button and Eeyore said, "Hello." The child then pushed a red button and a smile face appeared in a red rectangle on the screen. The child repeatedly pushed the red button, looked at the screen, but the computer's response rate to reproduce another smile face was much slower than the child's button pushes, and the child walked away from the computer, picked up a toy, and played with it. When Child 1 did not get a response at the time she expected after pushing a button, she deliberately and methodically pushed a red button, then a green button, then a blue button and finally a yellow button. She then looked at the screen. Child 2 pushed the red button continuously until the response showed up on the screen. Therefore, for young children, it is important to use a high-end computer with sufficient speed to run a multimedia program. The promptness of feedback will help to engage the children and attract their attention.

The multimedia program was revised based upon the evaluation results in Phase I. Although it was difficult to pin down which revised feature helped the children in their use for Phase II, it was clear what features did not work in Phase I. All children performed better in Phase II than in Phase I. The fact the children were six months older, and their prior computer exposure and the repeated use may be the main factors for this better performance. The revised program may have also been better tuned to the children's needs.

## Summary

It is demonstrated that children as young as two years old can engage in computer interactions. However, it appears from this research that purposeful interactions may not begin until the child is about two-and-a-half-years-old. It is apparent that prior knowledge has a strong role in a very young child's computer experience. Young children make sense of and assimilate what they see in the context of what they already know. Human interaction is shown to be vital to help these young children understand the computer environment. The keyboard seems to be the most appropriate input device for 2- to 3-year-olds.

While this case study describes computer interactions that occurred with very young children and shows positive interactive activity between 2-year-olds and computers, no prediction is intended. In this regard, causal-comparative, and experimental studies are suggested in order to determine the nature of purposeful computer interactions and very young children, the relationship between very early computer activity of children and later learning and development, and the possible benefits these children may receive in an early microworld environment. While there is research for pre-school aged children of four and five years, little exists with children two years of age. Hopefully, the findings of this study provided some useful information to this important, yet little investigated area.

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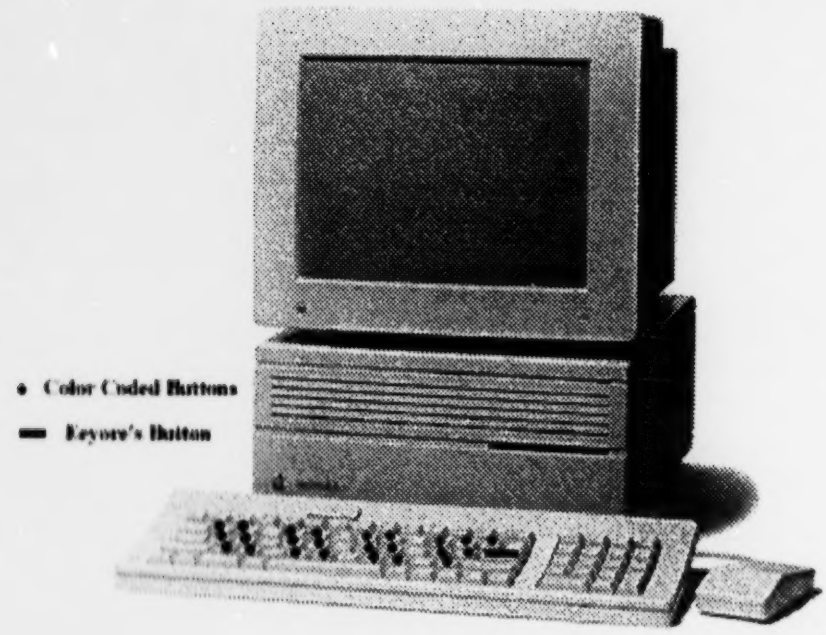
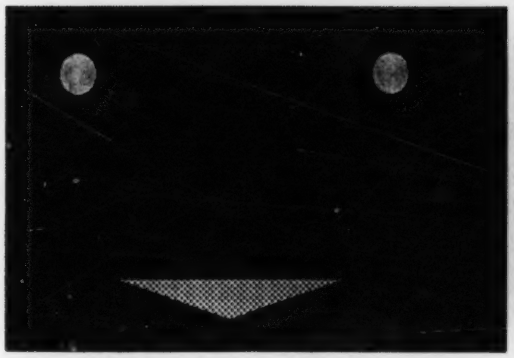
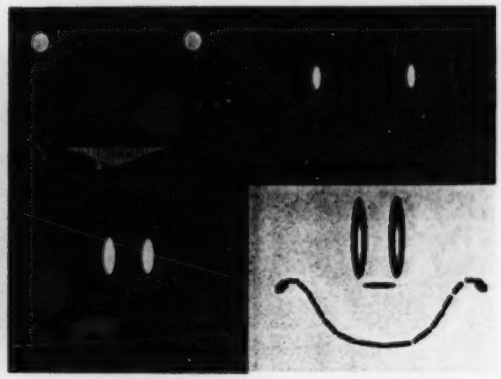


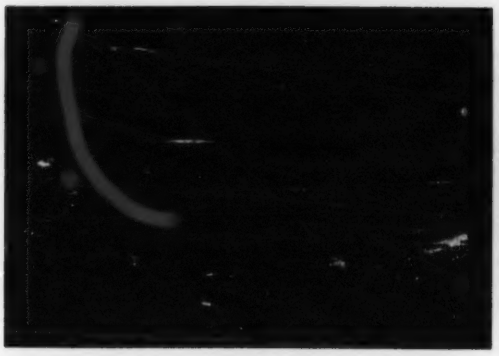

Figure 1. Square 3/8-inch Dymo plastic colored tape separates keyboard keys into four color groups arranged from left to right: red, green, blue, and yellow. Eeyore's picture covers the *Return* key.



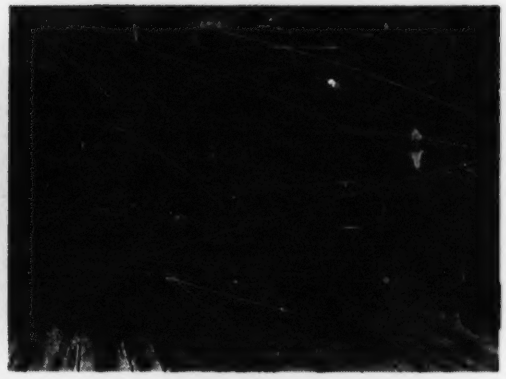
From Color Activity 1



From Color Activity 3



From Classification Activity 1



From Classification Activity 2

Figure 2. Screens from the interactive multimedia program "*The First Stone*"

Table 1.
Summary of Design Techniques Used

| **Multimedia Design Considerations** | **Techniques Used** |
|---|---|
| Age Appropriateness | • single keystroke<br>• using keyboard<br>• simple music with 7 note range<br>• colorful screen with bright colors<br>• simple and uncluttered screen design<br>• using children familiar characters and objects<br>• using audio, graphics and animation for presenting information<br>• no text used<br>• allowing assistance for a helper, and gradual withdraw of assistance from the helper |
| Learner Control | • child determining pace<br>• child determining path<br>• gradual withdraw of assistance from the helper |
| Real-World Representation | • using audio for instruction and feedback<br>• using animation and graphics for information presentation<br>• providing learning context through well-known children stories<br>• using situations in real life |
| Expanding Complexity | • gradual progress in activity complexity<br>• gradual withdraw of assistance from the helper<br>• encouragement of children's independence |

Table 2.
About the Participating Children at Phase I

| | | | | | Previously Used | | |
|---|---|---|---|---|---|---|---|
| Child | Age (YR:MO) | Sex | Computer at Home | Observed Parent Using Computer | Computer | Keyboard | Mouse |
| 1 | 2:7 | F | yes | yes | yes | yes | no |
| 2 | 2:4 | M | yes | yes | yes | yes | yes |
| 3 | 2:2 | M | no | no | no | no | no |
| 4 | 1:7 | F | no | yes | no | yes | no |

Table 3.
Time Spent at the Computer and Activities Completed for Phase I and Phase II

| **Phase I** | | | Activities Completed | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Color Activities | | | Classification Activities | | |
| Child | Time (Minutes) | Compared to Time Spent at Other NonComputer Activities | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 11 | more | x | x | x | x | x | |
| 2 | 14 | same | x | x | x | x | x | x |
| 3 | 50 | less | - | - | - | - | - | - |
| 4 | 8 | same | - | - | - | - | - | - |

| **Phase II** | | | | Activities Completed | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Color Activities | | | Classification Activities | | |
| Session | Child | Time (minutes) | Compared to Time Spent at Other Non-Computer Activities | 1 | 2 | 3 | 4 | 5 | 6 |
| A | 1 | 10.0 | same | x | x | x | x | x | x |
| B | 1 | 11.5 | same | x | x | x | x | x | x |
| A | 2 | 13.5 | same | x | x | x | x | x | x |
| B | 2 | 9.0 | less | x | x | x | x | - | - |
| A | 4 | 11.5 | same | x | - | - | - | - | - |
| B | 4 | 13.5 | same | x | x | x | - | - | - |

x = yes; - = no

Table 4.
Children's Performance with Color Activity 1 for Phase I and Phase II.

| **Phase I** | Attention To | | Buttons Pushed | | | | |
|---|---|---|---|---|---|---|---|
| Child | Screen | Keyboard | Eeyore | Red | Green | Blue | Yellow |
| 1 | x | x | x-h | x-h | x-h | x | x |
| 2 | x | x | x-h | x-h | x-h | x | x |
| 3 | x | x | - | - | - | - | - |
| 4 | x | x | x-h | - | - | - | - |

| **Phase II** | | Attention To | | Buttons Pushed | | | | |
|---|---|---|---|---|---|---|---|---|
| Session | Child | Screen | Keyboard | Eeyore | Red | Green | Blue | Yellow |
| A | 1 | x | x | x | x | h | x | x |
| B | 1 | x | x | x | x | x | x | x |
| A | 2 | x | x | x | x | x | x | x |
| B | 2 | x | x | x | x | x | x | x |
| A | 4 | x-h | x-h | x-h | x-h | x-h | x-h | - |
| B | 4 | x | x | x-h | x-h | x-h | x-h | x-h |

x = yes; - = no; h = with help.

Table 5.
Children's Performance with Color Activity 3 for Phase I and Phase II.

| **Phase I** | Pushed Button | | | | | Looked at Screen After Button Pushed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Child | R | G | B | Y | E | R | G | B | Y | E |
| 1 | x | x | x | x | x | x | x | x | x | x |
| 2 | x-h | x-h | x-h | x-h | x | x | x | x | x | x |

| **Phase II** | | Pushed Button | | | | | Looked at Screen After Button Pushed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Session | Child | R | G | B | Y | E | R | G | B | Y | E |
| A | 1 | x | x | x | x | x | x | x | x | x | x |
| B | 1 | x | x | x | x | x | x | x | x | x | x |
| A | 2 | x | x | x | x | x | x | x | x | x | x |
| B | 2 | x | x | x | x | x | x-h | x | x | x | x |
| A | 4 | - | - | - | - | - | x-h | x | x | x | x |
| B | 4 | x-h | x-h | x-h | x-h | x-h | x-h | x | x | x | x |

R = Red; G = Green; B = Blue; Y = Yellow; E = Eeyore; x = yes; h = with help.

Table 6.
Children's Performance with Classification Activities for Phase I

| | Correct Response to the Question On | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Classification Activity 1 | Ball | | | | | | Drum | | | | | |
| | 1st trial | | 2nd Trial | | 3rd Trial | | 1st trial | | 2nd Trial | | 3rd Trial | |
| Child 1 | x | | | | | | | | x-h | | | |
| Child 2 | x-h | | | | | | | | x | | | |
| Classification Activity 2 | Apple | | | Pie | | | Ball | | | Honey | | |
| | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Child 1 | x | | | | x | | | x | | | | x |
| Child 2 | x | | | x | | | x | | | | | x |
| Classification Activity 3 | Drum | | | Ball | | | Lemonade | | | Balloon | | |
| | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Child 1 | x-h | | | | | | | | | | | |
| Child 2 | x | | | x | | | | | x-h | | | x-h |

x = yes; h = with help.

Table 7.
Children's Performance with Classification Activities for Phase II

| | | Correct Response to the Question On | | | | | |
|---|---|---|---|---|---|---|---|
| Classification Activity 1 | | Ball | | | Drum | | |
| Session | | 1st Trial | 2nd Trial | 3rd Trial | 1st Trial | 2nd Trial | 3rd Trial |
| A | Child 1 | x | | | x | | |
| B | Child 1 | x | | | | x | |
| A | Child 2 | | x | | x | | |
| B | Child 2 | | x-h | | x-h | | |
| A | Child 4 | | | | | | |
| B | Child 4 | | | x-h | | | x-h |

| Classification Activity 2 | | Apple | | | Pie | | | Ball | | | Honey | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Session | | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| A | Child 1 | x-h | | | | x-h | | x | | | x | | |
| B | Child 1 | | x | | x | | | | x | | | | x |
| A | Child 2 | | x | | x | | | x | | | x | | |
| B | Child 2 | | | | | | | | | | | | |

| Classification Activity 3 | | Drum | | | Ball | | | Lemonade | | | Balloons | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Session | | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| A | Child 1 | x | | | x | | | x | | | x | | |
| B | Child 1 | x | | | | x | | x | | | | x-h | |
| A | Child 2 | | | x-h | | x-h | | x | | | | x-h | |
| B | Child 2 | | | | | | | | | | | | |

x=yes; h=with help.